

## PENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION  
(PCT Rule 61.2)Date of mailing (day/month/year)  
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L/XN88/ems/7pInternational filing date (day/month/year)  
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30 August 1999 (30.08.99)

Applicant

CLAEYS, Etienne

1. The designated Office is hereby notified of its election made: in the demand filed with the International Preliminary Examining Authority on:

23 March 2001 (23.03.01)

 in a notice effecting later election filed with the International Bureau on:2. The election  was was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

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- With international search report.
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 01/15887 A1

(54) Title: STRENGTHENING LAYER FOR USE IN COMPOSITES TO BE FORMED BY MEANS OF VACUUM TECHNIQUE

(57) Abstract: The invention relates to a strengthening layer for composites to be formed by means of vacuum technique, which layer substantially consists of a strengthening material and for a smaller part of substantially round transport threads for guiding the resin therealong, which threads are substantially form-retaining in cross-section and lie substantially in the direction of the resin transport.

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 00/08552

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B29C70/54 B29C70/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 08, 30 June 1999 (1999-06-30) & JP 11 058536 A (SEKISUI CHEM CO LTD), 2 March 1999 (1999-03-02) abstract ---	1-20
A	EP 0 348 831 A (WEIGEL ANGELA ;WEIGEL CLAUS (DE); WEIGEL SUSANNE (DE)) 3 January 1990 (1990-01-03) claims; figures ---	1-20
A	US 4 942 013 A (PALMER RAYMOND J ET AL) 17 July 1990 (1990-07-17) abstract; figures -----	1-20

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

### \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

2 January 2001

Date of mailing of the international search report

16/01/2001

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP 00/08552

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 11058536 A	02-03-1999	NONE	
EP 0348831 A	03-01-1990	DE 3821941 A AT 101555 T DE 58906970 D FI 893053 A	08-02-1990 15-03-1994 24-03-1994 30-12-1989
US 4942013 A	17-07-1990	NONE	

STRENGTHENING LAYER FOR USE IN COMPOSITES  
TO BE FORMED BY MEANS OF VACUUM TECHNIQUE

The present invention relates to a strengthening layer for composites to be formed by means of vacuum technique, as well as to an assembly of strengthening layers and composites containing the strengthening 5 layer.

Vacuum techniques are used to make composites in a closed mould system. A vacuum is produced in the mould by means of a small opening on an outer end of the mould, while the resin is supplied at the other end via a small 10 opening. The resin will fill the mould due to the underpressure in the mould.

Quite simple moulds are usually applied in such techniques. In some cases such moulds consist only of a lower mould with a cover foil. When a vacuum is produced 15 in the mould there results an external pressure on the mould of about 1 bar. When the mould is partially flexible, such as when a cover foil is applied as upper mould, this pressure is also exerted on the strengthening layer present in mould. Since the mould as it were 20 collapses and the strengthening layer is herein also compressed, the resin transport is in many cases made more difficult or even prevented.

Because the vacuum technique can be used with relatively low mould costs, it is an advantageous method. 25 To nevertheless enable the use of this vacuum technique with these simple moulds use is currently made of so-called "bleeders". These are intermediate layers inserted between the strengthening layers so as to still allow resin transport. Such "bleeders" are for instance 30 continuous glass mats, which cannot be compressed by the external pressure on the mould and its content. Such "bleeders" are however generally a disruptive element in the end product since they cause unnecessary thickness, weight, resin and material consumption. Furthermore, they

leave behind a resin-rich location in the end product, thereby creating the danger of air inclusion.

The present invention therefore has for its object to provide a strengthening layer which is particularly 5 suitable for forming composites by means of vacuum technique.

This is achieved with the invention by a strengthening layer which substantially consists of a strengthening material and for a smaller part of 10 transport threads of substantially round and substantially form-retaining cross-section for guiding the resin therealong, which threads lie substantially in the direction of the resin transport. Because of the form-retaining nature of the transport threads they are 15 not flattened by the external pressure but retain their form. It has been found that sufficient openings thereby remain along the threads to enable resin transport. The transporting speed of the resin can be influenced by the choice of the thread thickness and by the number of 20 threads.

The transport threads can lie in the same plane as the rest of the strengthening material. In that case they preferably replace a part of this material, whereby no extra weight is added. The invention is however also 25 effective when the transport threads are situated between the different layers of strengthening material.

Although the problem of the strengthening material being compressed can occur with different types of strengthening material, it is a particular problem in the 30 case of strengthening material which takes at least partly the form of endless threads lying substantially parallel adjacently of each other, or multifilaments. Multifilaments are bundles of separate threads which are not mutually attached to each other within a bundle and 35 are also not intertwined. They therefore spread into a flat surface in the case of external pressure.

The form-retention of the transport threads according to the invention can be achieved in different

ways. It is thus possible to apply two or more twined single threads or a torsional single thread. In addition, form-retention can also be achieved by means of a substantially rigid coating applied to the whole or 5 partial surface of the thread. Such a coating again ensures that the threads cannot be compressed. Although it is evident that a coating over the whole surface gives the best result, it is however also possible, in order to save material, to suffice with a coating in parts at 10 intermediate distances such that sufficient rigidity is provided for the threads to prevent compression thereof under a pressure of about 1 bar. As coating can for instance be used a glue or other finishes known in the art of textile processing.

15 When the transport threads are monofilament threads, they already form one whole and for this reason cannot be flattened. A similar result can be achieved when the transport threads are provided with a sheath. Such a sheath can for instance be a knit or a braiding. The 20 form-retention of the transport threads can likewise further be ensured in that they form part of a structure of threads which are mutually connected by a binding such that the round form of the transport threads cannot be distorted, or hardly so. Examples of such structures are 25 for instance gauzes or webs manufactured according to Rachel technique.

Both the strengthening materials and the transport threads according to the invention can be formed from the usual strengthening materials applied for the 30 reinforcement of plastics, such as glass, carbon, kevlar, flax, other vegetable or synthetic fibres or combinations thereof. The material applied for the transport threads can be the same as the rest of the strengthening material or different. Glass is mostly used as strengthening 35 material and as material for the transport threads.

A strengthening layer according to the invention will in practice generally be applied in an assembly of a plurality of layers. Such an assembly comprises at least

one strengthening layer according to the invention and can in addition comprise for instance rovings and mats. It is however recommended to employ the transport threads distributed uniformly over the different strengthening 5 layers, since the most homogenous possible resin distribution is then obtained.

The invention finally extends to composites which consist of at least one layer or assembly according to the invention embedded in resin.

10 By using one or more strengthening layers according to the invention in the manufacture of composites using the vacuum technique, a composite without intermediate layer (bleeder) can now be made with a great number of advantages. Firstly, a resin-rich layer is prevented from 15 forming in the middle of the laminate. There is the danger of air inclusion taking place in such a layer. In addition, by choosing the same material for the transport threads as for the rest of the layer it is possible to prevent the end product containing laminate-foreign 20 substances. Since the transport threads according to the invention preferably replace a part of the rest of the strengthening material, the composite will not need a greater thickness than is actually desirable. Since according to the invention no extra layer is needed and 25 the threads are preferably used to replace a part of the strengthening material, no unnecessary consumption of resin is required. An additional bleeder, which has no function in the final laminate, moreover increases the weight of the laminate. This is also prevented by the 30 transport threads according to the invention. Further prevented when the thickness is the same is that less strengthening can be inserted. Since a bleeder itself already has a relatively great thickness, less real material providing strengthening can be used. The bleeder 35 is formed from criss-cross fibres which provide no or hardly any strengthening in one direction.

In this application "composite" is understood to mean a material in which the supporting function is taken

over almost entirely by the reinforcement material (strengthening material). The resin herein has a sealing character and functions for the purpose of cohesion and stress transfer.

5 "Vacuum technique" is understood to mean the suction of resin by means of vacuum through a closed mould having therein one or more strengthening layers for the purpose of forming a composite.

10 A "strengthening layer" is a quantity of strengthening material displaying cohesion. The term "strengthening material" is used for the components of which a strengthening layer consists, such as multifilaments, glass rovings and so on.

15 The invention will be further elucidated with reference to the example following hereinbelow.

#### **EXAMPLE**

##### Comparison of resin transport in different types of strengthening material

20 1. Test arrangement

The elongate strengthening layer for testing was placed between two sheets of foil functioning as mould. The foil sheets were sealed all round in order to enable creation of a vacuum in the mould. A vacuum was applied 25 at the one end of the mould, while resin was fed into the mould at the other end. A measuring rule was positioned in longitudinal direction of the mould to enable determining of the distance covered by the resin per unit of time.

30

2. Strengthening materials

As first comparison material an assembly of strengthening layers was manufactured from six layers of unidirectional webs, wherein in longitudinal direction 35 each layer had a weight of 1125 g/m<sup>2</sup> glass rovings and in transverse direction a weight of 75 g/m<sup>2</sup> glass rovings. A glass mat of 50 g/m<sup>2</sup> was attached hereto. Such an assembly cannot be formed without any problem into a composite by

means of vacuum techniques. A continuous glass mat of 450 g was therefore placed as "bleeder" between the third and fourth layer of unidirectional webs. The thickness of this continuous mat was roughly 0.8 mm. The thickness of 5 each layer of unidirectional web was 0.9 mm.

As second comparison material the above described assembly of strengthening layers was used without the bleeder.

In the material according to the invention 20 g/m<sup>2</sup> 10 glass roving in the above mentioned web of 1250 g/m<sup>2</sup> was replaced by twined glass yarn in the direction in which the resin transport has to be directed. The web is not changed appreciably by this replacement.

### 15 3. Result

By means of the comparison material with the stated (continuous mat) bleeder the resin can be transported over about 35 cm in 15 minutes with the vacuum technique. Without the continuous glass mat as bleeder the transport 20 is found to amount to only 10 cm in 15 minutes. The resin transport in the material according to the invention amounts to 35 cm in 15 minutes.

It can be seen from the foregoing that with much less material and in simple manner an at least equally 25 good result can be obtained according to the invention as when a bleeder is applied.

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## CLAIMS

1. Strengthening layer for composites to be formed by means of vacuum technique, which layer substantially consists of a strengthening material and for a smaller part of transport threads of substantially round and substantially form-retaining cross-section for guiding the resin therealong, which threads lie substantially in the direction of the resin transport.

2. Strengthening layer as claimed in claim 1, characterized in that the transport threads lie in the same plane as the rest of the strengthening material.

3. Strengthening layer as claimed in claim 1 or 2, characterized in that the transport threads lie against one or both sides of the strengthening layer.

4. Strengthening layer as claimed in claims 1-3, characterized in that the strengthening material takes at least partly the form of endless threads lying substantially parallel adjacently of each other, or multifilaments.

5. Strengthening layer as claimed in claims 1-4, characterized in that the form-retention of the transport threads is achieved in that they consist of two or more twined single threads.

6. Strengthening layer as claimed in claims 1-4, characterized in that the form-retention of the transport threads is achieved in that they consist of torsional single threads.

7. Strengthening layer as claimed in claims 1-4, characterized in that the form-retention of the transport threads is achieved in that they consist of a coating applied to the whole or partial surface of the thread.

8. Strengthening layer as claimed in claim 7, characterized in that the coating is a glue.

9. Strengthening layer as claimed in claims 1-4, characterized in that the form-retention of the transport

threads is achieved in that they are monofilament threads.

10. Strengthening layer as claimed in claims 1-4, characterized in that the form-retention of the transport threads is achieved in that they are provided with a sheath.

11. Strengthening layer as claimed in claim 10, characterized in that the sheath consists of a knit.

12. Strengthening layer as claimed in claim 10, characterized in that the sheath consists of a braiding.

13. Strengthening layer as claimed in claims 1-4, characterized in that the form-retention of the transport threads is achieved in that they form part of a structure of threads which are mutually connected by a binding such that the round form of the transport threads cannot be distorted, or hardly so.

14. Strengthening layer as claimed in claim 13, characterized in that the form-retention of the transport threads is achieved in that they form part of a gauze.

15. Strengthening layer as claimed in claim 13, characterized in that the form-retention of the transport threads is achieved in that they form part of a web manufactured according to the Rachel technique.

16. Strengthening layer as claimed in any of the foregoing claims, characterized in that the transport threads are formed from glass, carbon, kevlar, flax, other vegetable or synthetic fibres or combinations thereof.

17. Strengthening layer as claimed in any of the foregoing claims, characterized in that the strengthening material is formed from glass, carbon, kevlar, flax, other vegetable or synthetic fibres or combinations thereof.

18. Strengthening layer as claimed in any of the foregoing claims, characterized in that the transport threads are manufactured from the same material as the strengthening material of which the rest of the layer consists.

19. Assembly of strengthening layers, comprising at least one strengthening layer as claimed in any of the foregoing claims.

20. Composite consisting of at least one layer  
5 embedded in resin as claimed in claims 1-18 or an assembly as claimed in claim 19.

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## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 00/08552A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B29C70/54 B29C70/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 08, 30 June 1999 (1999-06-30) & JP 11 058536 A (SEKISUI CHEM CO LTD), 2 March 1999 (1999-03-02) abstract ---	1-20
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A	US 4 942 013 A (PALMER RAYMOND J ET AL) 17 July 1990 (1990-07-17) abstract; figures ---	1-20

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

2 January 2001

16/01/2001

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP 00/08552

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
JP 11058536	A 02-03-1999	NONE		
EP 0348831	A 03-01-1990	DE 3821941 A	08-02-1990	
		AT 101555 T	15-03-1994	
		DE 58906970 D	24-03-1994	
		FI 893053 A	30-12-1989	
US 4942013	A 17-07-1990	NONE		

PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference L/XN88/ems/7p	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP00/08552	International filing date (day/month/year) 30/08/2000	Priority date (day/month/year) 30/08/1999
International Patent Classification (IPC) or national classification and IPC B29C70/54		
Applicant SYNCOGLAS S.A. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I  Basis of the report
- II  Priority
- III  Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV  Lack of unity of invention
- V  Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI  Certain documents cited
- VII  Certain defects in the international application
- VIII  Certain observations on the international application

Date of submission of the demand 23/03/2001	Date of completion of this report 14.08.2001
Name and mailing address of the international preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016	Authorized officer Van Wallendael, A Telephone No. +31 70 340 3611



INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT

International application No. PCT/EP00/08552

I. Basis of the report

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-6 as originally filed

Claims, No.:

1-20 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- the language of publication of the international application (under Rule 48.3(b)).
- the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- contained in the international application in written form.
- filed together with the international application in computer readable form.
- furnished subsequently to this Authority in written form.
- furnished subsequently to this Authority in computer readable form.
- The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- the description, pages:
- the claims, Nos.:
- the drawings, sheets:

5.  This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**

International application No. PCT/EP00/08552

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes:	Claims 1-20
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-20
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-20
	No:	Claims

2. Citations and explanations  
**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

Closest prior art document:

D1: US -A-4 942 013

**Novelty:**

The prior art does not disclose a strengthening layer consisting of strengthening material and a smaller part of transport threads of substantially round and form-retaining cross section for guiding matrix resin during moulding, suitable to be used in vacuum composite moulding techniques. The subject matter of claims 1 is therefore new in respect of the prior art as defined in the regulations (Rule 64 (1)-(3) PCT).

**Inventive Step:**

Known prior art techniques for manufacture of composites involve lay-up of reinforcing fibres and resin distribution layers, -tubes or -rods on a mould, after which resin is introduced into the lay up. The problem is related to the fact that these resin distribution elements have to be placed separately from the reinforcing material which is cumbersome in the case of discrete resin distribution rods / conduits or results in a relatively weak and resin rich layer in the final composite.

These problems are solved by using a strengthening layer in accordance with claim 1. The use of such a layer does not result in resin rich layers and the problem of independently positioning of resin distribution rods or conduits is prevented.

The prior art does neither disclose nor render obvious such a layer as defined in the claims. Therefore claim 1 meets the criteria as set forth in Article 33 (3) PCT as they involve an inventive step (Rule 65 (1)(2) PCT).

The dependent claims 2 to 20 add features to the independent claim, and thus also relate to novel and inventive subject matter.

**Industrial Applicability**

The claimed subject matter is considered to be industrially applicable and thus fulfilling the requirements of article 33(4) PCT.

**Re Item VII**

**Certain defects in the international application**

Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein.

Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would have been appropriate, with those features known in combination from the prior art (document D1) being placed in the preamble (Rule 6.3(b)(I) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

**Re Item VIII**

**Certain observations on the international application**

In claim 1 it is not sufficiently clear what is meant with the expression 'substantially form-retaining' as the form retention of an object depends on the load applied thereto. Claim 1 has therefore been interpreted as transport threads retaining their cross sectional shape during the vacuum moulding process.